SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

No. 1786.—Vol. XXXIX. LONDON, SATURDAY, NOVEMBER 13, 1869. {STAMPED .. SIXPENCE. UNSTAMPED. FIVEPENCE.

Original Correspondence.

MR. BIDDER'S COAL-BREAKING MACHINE.

SIR,—As the manager of the Harecastle Colliery, I feel it to be my duty to call your attention to an erroneous statement contained in your Correspondent's report of the experiments made at Usworth Colliery with Mr. Bidder's coal-breaking machine, as it appears in last week's Journal, and to ask your permission to rectify the error.

After detailing the experiments at Usworth, the writer states as follows:—"It may be added that the machine, although new to this district, was tested in Staffordshire about a year ago at the Harecastle Collieries, where 90 men were recently killed." I have to state that we have never had any accidents with gas at Harecastle by which lives have been lost. At the Talk-o'-th'-Hill Colliery, where the machine was tried, an explosion occurred in 1866, where 90 men were killed, but this is a different colliery from Harecastle, although in the same locality, and I have no doubt that the misstatement alluded to has arisen from the circumstance of the machine in question having been tried both at the Talke Colliery and at Harecastle.

Great George-street, Westminster, Nov. 8. W. Y. CRAIG.

HYDRAULIC MACHINE FOR BREAKING DOWN COAL.

SIR,—Having read the description given in last week's Journal of Mr. Bidder's machine, I cannot see how it can be called a Coal-Cutting Machine. If Mr. Bidder could have carried out what he first set out with (which I much doubt) then it might have very properly been called a coal-getting machine, but not a coal-cutting machine, except the drilling apparatus be called cutting coal, which he also appears to claim. This or very similar apparatus has been in use the last seven years in collieries in the neighbourhood of Leeds. I believe they were first introduced into the Rothwell Haigh Colliery, belonging to Messrs. J. and J. Charlesworth, and are regularly used there, with but very slight difference to the one you describe. Instead of a small aperture being punched into the coal in the ordinary way to insert the fulcrum to take the resistance, a suitable and adjustable bar or post is screwed between the roof and the floor of the mine; and rotary motion is given to the drill by the brace or ratchet brace, and not by the screw, the screw being used to propel, or give the forward motion, to the drill at any speed differing from the screw required. In my opinion, a more convenient method.

I have not seen Mr. Bidder's coal-breaking down machine in operation, therefore do not wish to say anything against it; but I have seen very recently one of Mr. Grafton Jones's patent at work—and it took a good collier three hours to make the place to fix it ready to commence to push the coal down, but it is not pushed down yet,—and I thought it looked the likeliest of the two. PICK.

THE SAFETY-LAMP EXPERIMENTS.

SIR,—Your correspondent, Mr. Hann, in the Supplement to last week's Journal, says that the apparatus was not in perfect order at the trial on Sept. 30, but that he has now got it screwed up, and that he will throw more light on the matter when the next trial takes place. We must, therefore, wait patiently for the next trial, which I presume will not be long delayed.

I shall now proceed to make a few remarks respecting the Davy lamp, and I think that I shall show that Mr. Hann "seems to be very willing to rush into loose and groundless assertions."

In the Houghton case, a bore-hole was made into old workings charged with gas, and the Davy lamp was left in a position near this bore-hole, the gas playing strongly upon it. The result was, I think, that the gas was fired—at any rate, the coal was ignited—and considerable trouble ensued, *but no explosion occurred*. It was very similar, indeed, to a blower, and the result was just what might have been expected; and I venture to assert that if the Stephenson lamp had been placed there instead of the Davy the Stephenson would have been instantly extinguished.

With respect to Ferndale, Pelton Fell, &c., we have no evidence whatever to show that the explosions resulted from the failure of the lamps, but strong grounds for attributing the sad occurrences to other causes. Opinions we have plently, but this is not evidence, and it would require a moderate sized volume to contain all the opinions, and even a brief *resume* of the evidence given at the inquests on those cases. We, therefore, adhere to the opinion expressed, "that imperfect ventilation, and the incautious use of gunpowder, have been, without doubt, the causes of all modern explosions."

I will not go so far back as 1818, but will dwell a little on the Springwell case, which occurred in 1833, as I happen to be intimately acquainted with every detail connected with that very remarkable and awful event. The explosion here alluded to by Mr. Hann was of a most violent character, as the flame, after traversing the large district where it originated, reached the shaft, and the men at the bottom were severely scorched, the brattice in the shaft was ignited also, and continued to burn some time. The Springwell Colliery was at that time worked by a single shaft, divided into three portions by a brattice, and the workings were going on in three separate districts—1, the north and north-east district; 2, the south district; 3, the east district. The two latter districts were worked almost exclusively with the Stephenson safety-lamp, and the first district was worked with open candles, and it was here that *the explosion occurred*. The seam was about 5 ft. in thickness, with a most excellent roof, and the district was almost all worked in the whole, but no pillars were taken off. The main drifts proceeded some distance due north, then north-east, and finally due east; and here some broken ground was found, a broken roof, and some small faults; and blowers of gas were found also. On the day when the explosion occurred the men in those leading places, where the faults and the gas were found, were alarmed, and lamps were got for them to work with instead of candles. But when the air column left those men it was carried north, and afterwards returned along the face of a large extent of whole bords, where the men were still working with candles; and the main air column gradually fouled from the gas produced at the blowers, and at length exploded at some of those candles. A most fearful explosion resulted, every soul in the district was destroyed, and the men, as remarked above, scorched at the bottom of the shaft, and the brattice fired. The men from the other districts, where lamps were used, all escaped, although the passage up the shaft past the burning brattice was both a difficult and dangerous one. The exploded district was only partially explored when a fire was discovered, the small coals having been ignited, and a retreat was made, and finally the shaft was closed by a dam; and some months elapsed before the workings were cleared and the bodies of the men recovered. If we are to take this case as a specimen of Mr. Hann's accuracy, he cannot be acquitted of making "loose and groundless assertions."

With respect to the Wallsend case, in 1835, the generally-received theory respecting it was that the main return fouled at a certain point, and that a party of stone-men passed through a pair of doors, in order to get their tools, &c., and that those men fired the gas there with a naked light; and this appears to be the most natural inference, from the evidence given at the inquest. Some stress is laid on the fact that the experiments are conducted with mixtures of fresh air, taken direct from the down-cast shaft, and manufactured gas, and justly so. It is well known that some of the hydrocarbons are extremely explosive, and the mixture thus produced differs very widely from the mixture usually found in mines. It would have been interesting, if not useful, if an analysis of the gas used had been given—that is, the common illuminating gas used, and the pit gas also, but an inspection of the analyses given by various authors will show that there is an important difference between common illuminating gas and pit gas. Very rude experiments will prove this, but more elaborate and scientific trials would certainly be more satisfactory. In the first series of experiments common illuminating gas was used, and trials made with a Davy lamp, and a revolving apparatus. From these experiments the Committee concluded that the "lowest velocity at which the flame passed (the Davy lamp) was 13 feet per second."

When the last series of experiments were made pit gas was used to a certain extent. First the Davy was subjected to the test with pit gas, and exploded, but I can find no case in the Tables where the Stephenson was fired with pit gas. There is, indeed, one case recorded where this lamp exploded with pit gas, the velocity being 21 ft. per second; but it is stated in connection with that case that the lamp exploded *through a broken glass*. I hope that I have made no error here, but I have examined the published accounts most carefully, and find it as stated.

Mr. Hann entirely mistakes my meaning with regard to trials "in ordinary working practice." What I wished to convey was not ordinary working in a clean atmosphere, but working in a mine subject to sudden discharges of gas from blowers, goaves, &c. Now, with respect to blowers, they sometimes burst out suddenly, and the result simply is that the Stephenson lamp is extinguished. Blowers generally, if not always (I do not remember a single exception), break out at the face of a bord or headway, indeed, in most cases at the face of an exploring drift, and the gas issues in such a dense state that most lamps would be extinguished, and if a candle is found in such a position the gas is ignited, and continues to burn in the face of the drift.

It is evident that the common idea entertained by the public, and the notion of theorists, is that when a "blower" is tapped a tremendous power is at once evolved—that, in fact, something analogous to a powder magazine has been broached, and in consequence a great explosion may at once ensue. But this view is quite erroneous; the materials for a serious explosion, and necessary conditions, are not present. The current of air in the bord or heading may be charged considerably *above* the explosive point. In the case at Springwell, in 1833, if the men near the point where the gas was issuing had been kept working with candles the explosion would have occurred much sooner, and would have been comparatively of little importance; but the gas was mixed with the current of air and spread over a large area, the most explosive point was reached, and then contact with candles occurred, which completed the catastrophe. It will be seen from this that the greatest danger from blowers is not to be found (at any rate, not instantaneously) at the point of issue, but in allowing the gas produced to spread over and accumulate in large spaces.

Mr. Hann does not venture to assail my main position; he admits, on the contrary, that the Stephenson lamp has been in constant use in the most fiery collieries for a period of 30 years (nay, 50 years), and that no accident has ever been attributed to it. True this is, speaking logically, only negative evidence; but it is, he must admit, very strong evidence as to its safety. Let me add that it has been put to the test in every conceivable position in fiery mines, combined with a powerful ventilation, and it has never once failed. It has been subjected to powerful blowers, and to the action of explosive currents, propelled by falls in goaves, in gas drifts, &c.; and it has gone through those ordeals in all cases with perfect safety to the miners. I must submit that even if in the experiments made pit gas only was used, yet the admission of fresh air direct from the downcast pit must cause those currents to be much more explosive that the explosive currents met with in the internal workings of a mine.

Taking a broad view of the question, without going into details or technicalities, I would ask how the facts are to be accounted for—that is, the passing of the Stephenson lamp through every trial that can happen to be met with in mines without adopting the hypothesis that the lamp is a safe and reliable one? I wish I could conclude by giving a few cases of remarkable occurrences met with in connection with the use of lamps in mines, but I must postpone them until next week.—*Newcastle, Nov.* 10. M. E.

NEW SAFETY-LAMP—THE MINERS' FRIEND.

SIR,—You were kind enough in the Supplement to the Journal of Oct. 23 to give a description, with illustration, of my Patent Safety-Lamp for Mines. Although I invented it for the protection of miners, as its name—"The Miners' Friend"—implies, it is equally necessary on board of ship, as a security against fire and against explosions in the bunkers. I may mention three explosions in the bunkers of men-of-war that have occurred quite lately, and which might have been attended by very serious consequences. A few months back, whilst the chief engineer of the Fredrich Wilhelm, Prussian iron-clad, was examining the coals an explosion took place. Luckily he was just under one of the coal shoots, and was driven up against the deck overhead, and only seriously bruised. Very recently two explosions have taken place in the bunkers of our own iron-clad, Minotaur, the last explosion being most likely fatal to a stoker. We may look back to the burning of the Kent in the early part of this century, and speculate as to how many ships have been burnt between the time of her destruction and the loss of our line-of-battle-ship Bombay, six years back; and also speculate how many of these ships were burnt from the same cause—the incautious use of naked lights. The use of a lamp such as mine would, I believe, be the means of saving many ships and many hundred lives every year. Sailors are proverbially careless with lights, but with my safety-lamp they cannot be careless without at once extinguishing it. I have sent drawings of the lamp to the Admiralty, so they have the option of adopting it.

Portsmouth, Nov. 7. ARTHUR H. GILMORE, Com. R.N.

PROPOSED GREAT WESTERN MARITIME SHIP CANAL.

IMPROVED COMMUNICATION BETWEEN SOUTH WALES AND THE WEST AND SOUTH OF ENGLAND, THE METROPOLIS, AND THE CONTINENT.

SIR,—It has been suggested that the English and Bristol Channels should be united by a navigable communication, connecting, as it would, the South Wales coal fields and the Midland manufacturing districts with the West, South, and South-Eastern Counties, London, and the Continent. The country between Bridgwater and Exeter offers natural facilities for such a work. The canals in the locality have never been connected so as to form a through route, and the construction of such a channel from sea to sea would be of great advantage. Two hundred and ninety miles would be saved between South Wales, Bristol, Gloucester, &c., and the South, South-Eastern, and Eastern Counties and London, and the distances would be less as regards France, Belgium, Holland, North of Europe, and the Baltic. The dangerous passage round the Land's End would be avoided, to the saving of life and property, and freights, rates of insurance, &c., would be reduced.

A great impetus would be given to the trade in coal, iron, and other minerals, timber, agricultural products, manufactures, and general merchandise. *The Southern Counties would be supplied with cheap fuel.* The Welsh coal (for want of direct means of transport) is almost unknown in the South of England, and the inhabitants there pay much higher prices than those residing in other parts. This anomaly should cease. The Welsh house coal is not inferior to that from the North of England, and would be placed equi-distant from the metropolis, and nearer to the Southern Counties and French coast, and could compete advantageously. The produce of the western collieries would be more cheaply conveyed to the South by a *canal* than by the proposed railway under or across the Severn. The expense of railway carriage would prevent competition from the Midland coal fields. The (smokeless) Welsh coal is now largely used in locomotives and steam vessels, also for manufacturing purposes.

The proposed Canal should commence at Combwitch, on the River Parret, and, proceeding *via* Bridgwater, Taunton, and Exeter, terminate at the sea at Langstone Point to the west of the mouth of the Exe—length, 59 miles. A port (forming a harbour of refuge) would have to be made at the southern mouth of the Canal, always accessible to the largest vessels, and would be a boon to the shipping interests. The Canal would have to accommodate screw colliers and other ships of large tonnage, and the following dimensions are suggested:—124 ft. wide at surface, 31 ft. wide at bottom, and 21 ft. deep. The assumed cost of Canal, Harbour, and Dock Works, preliminary expenses and contingencies, &c., is 3,500,000*l.*

Disregarding the large and increasing trade in iron to France, Russia, &c., and other mineral and miscellaneous traffic, the coal traffic is estimated as under:—

English Counties and Channel Islands, London, and France, 4,261,334 tons.	
This tonnage, at ¼d. per ton per mile, would produce	£261,894
Less 35 per cent. for working expenses and ordinary maintenance..	91,658
Leaving a profit of.....	£170,236

Or nearly 5 per cent. on the capital of 3,500,000*l.* obtained from the carriage of coal alone, and quite irrespective of the large revenue which would be derived from other sources.

The project is one deserving the attention of the Legislature.

Mars Hill Villa, Exeter. G. ANDERSON (for the Promoters).

NOTES ON COAL MINING—MONMOUTHSHIRE.

ABERCARN COLLIERY.

SIR,—This colliery is situated about two miles north from Risca pits in the western valley. The strata dip northward from Risca to Abercarn, and from the latter one mile further north to Newbridge, where the coal measures are said to commence to rise northward. The present drawing shaft at Abercarn is sunk to the Black Vein—300 yards deep—and coal has been raised from that seam at this pit exclusively for five years. It is sunk on an almost untouched coal field there being no other colliery—with the exception of Risca—within many miles of it, which will account for there being a large production of gas from the Black Vein, and that being thrown off in a peculiar manner. The Black Vein coal is of the bituminous quality, withstands exposure to the weather for a long period, and makes excellent coke. About 600 tons of coal raised daily, but the engine power is equal to a much larger output than this. The coal is all screened, the small is utilised by coking in ovens; the large coal with the coke is sent to Newport for exportation. The colliery is carried on by the Ebbw Vale Iron and Coal Company, the royalty is leased by them from Lady Llanover.

ABOVEGROUND MACHINERY.—The erections and machines at Abercarn are amongst the best and most substantial in Monmouthshire and Wales; the winding-engine house is 68 ft. high from the surface, built of ashlar stone. The pulley frame, 60 ft. high from the surface, is constructed of ¾-in. wrought-iron plate, is fixed in masonry extending 7 ft. below the surface. The winding-engine has two 42-in. vertical cylinders, 8-ft. stroke, acting direct up to the rope-rolls, 24 lbs. steam pressure, double-seat valves, steam condensed, the vacuum gauge shows 22 in. A range of eight Cornish boilers supply this engine with steam; they are placed in a house. The rope-rolls are 22 ft. diameter, increased about 20 inches in diameter in winding up the pit: the ropes wear 18 months on an average, the pulleys are 17 ft. in diameter. The engine works with two bands, raises in each carriage two trams in two decks, each tram holds about 1 ton of coal; the carriages run on three wire-rope guides. The rope-rolls rest on two middle walls, with openings supported by girders, under which the cylinders are placed. The downcast pit used for coal drawing and pumps is 22 ft. by 18 ft., and walled from top to bottom. The upcast pit, about 20 yards distant from the downcast, is 17 ft. by 11 ft.; it is closed at top, and the smoke is conveyed from it 60 yards down into another pit sunk 60 yards, 10 ft. diameter, and 10 yards from the other. This has a high chimney erected upon it, and the smoke is conveyed through to the atmosphere. The pumping-engine is placed between the two large pits. It originally worked in Cornwall, but has been in operation here five years; 85-in. cylinder, 10-ft.

stroke, 8 ft. in pit, condensing, vacuum gauge shows 27 lbs. In summer the engine goes two strokes per minute, day and night; in winter will go three strokes per minute. There are five sets of pumps connected with it, pumping from the depth of 311 yards; the lowest is a lifting set, 17 in. bucket; the rest are all forcing, increasing in diameter as they ascend; they are 16, 17, 18, and 22-in. rams respectively, the main pipes are 1 in. larger in diameter. The screens are about 100 yards from the pit, and on a higher level; an engine is used to draw the laden trams from the pit to the top of the screens, the engine is placed nearly midway, at right angles to the road; it has a 14-in. horizontal cylinder, 2-ft. stroke, cog-wheels 1 to 6, two drums 6 ft. diameter; the wire-rope is attached to both drums, passes round one sheave at the pit and one at the screens, and two more opposite the engine, by this means it works both ways, with two drums; it draws the laden trams only, the empty ones run back to the pit another way. A large beam-engine is placed for raising coal from the upper seams in the upcast pit; at present it is not used, but is intended to be used again for that purpose. A 14-in. horizontal engine, with cog-wheels 1 to 9; drum, 4 ft.; and hemp-rope, is now used as a capstan engine, but the cylinder is being replaced by a much larger one, in order to adapt the engine for hauling underground, with two drums, and new cog-wheels; the present drum and gearing will still be used as a capstan when attached to the new engine. There are five boilers to supply these three engines with steam, and also an engine placed underground, being conveyed in the downcast pit by 9-in. pipes to the engine; these pipes are covered with felt and deals.

UNDERGROUND MACHINERY.—The Black vein workings extend nearly one mile west from the pit; at present this level is suspended; the engine on the surface, last described, is being altered for hauling on this level in and out; main and tail ropes will be brought down the pit in boxes for this purpose. The level east of the pit is also about one mile in length to its extremity, and is now adapted for engine haulage, 1500 yards in length eastward; the engine is placed 60 yards east from the pit, alongside the engine plane; it has two 20-in. horizontal cylinders, 3¼-ft. stroke, 35 lbs. steam-pressure; two 7-ft. drums underneath the road; one main rope, 1¼ in., steel; one tail-rope, 1 in., steel. The engine works with these ropes, in the first place; a plane 1100 yards long, rising and falling slightly eastward; 32 trams each journey. The main rope, it should be observed, works backward to the pit, round a sheave, and crossed before it is taken into the plane eastward; this enables the full journey to be drawn close up to the pit, and past the engine. The tail-rope at the end of 1100 yards passes round a 7-ft. horizontal clip-pulley, connected with a 6-in. upright shaft, bevel-wheels of equal diameter, and a horizontal shaft, all fixed in a frame, by this means two 5-feet drums on the last shaft work 16 trams up and down a plane 500 yards long, south of this point; the dip undulates, but 3 inches per yard is the average dip southward. While the engine is drawing the laden trams on the 1100 yards plane, it is also drawing the laden trams out from the south plane; on the latter arriving at the top the drum is thrown out of gear, and the train is stopped. In drawing inwards, the engine starts both planes at once with the tail-rope drums; the engine only slackens its speed while the tail-drum of the south plane is put out of gear. The upright and horizontal shafts are in motion as long as the engine is working. From the same upright shaft the engine plane will be extended eastward 400 yards further, by means of a 5-feet pulley, on the upright shaft, and an endless chain, 9-16ths in. thick; this is being made a double road, and the trams will be in progression in and out as long as the engine is going. This district is at present worked by horses; the engine is considered of sufficient power to work this plane at the same time with the others; the full and empty trams will be hauled together, the trams being attached to the chain one or more at once.

METHOD OF WORKING.—The coal is worked principally on the stall and pillar system, though a little coal has been got on the long wall principle; but the seam is considered not adapted for it, owing to its thickness, and the absence of filling up material. In the stall and pillar system the stalls are made 18 yards wide, double roads, pillars of coal 10 yards, these are usually driven east and west from each side of a pair of cross-headings, the latter 3 yards wide, and with a pillar of coal between of 18 yards. This is the most advantageous way of driving the stalls, as they go then at right angles to the grains of the coal, which occur at regular distances, and parallel to the slips, which occur irregularly. But this is not made the rule; the cross-headings are driven principally to suit the rise, which is very variable in this district; the stalls are frequently driven north and south, as well as in the contrary direction, so that their direction is not a point of great moment as to facility of working.

SECTION OF THE BLACK VEIN IN THE EAST LEVEL.
Cliff roof. Generally inferior.

1.—Shale and rashes			1 ft. 6 in.	
2.—Top coal, left for roof			2 ft. 6 in.	
3.—Good coal			6 0	
4.—Parting, shale, holing			0 1	
5.—Bed coal, good		2 0=	10 6	
6.—Lower bed coal, inferior			0 10	Thrown to gob.
7.—Underclay.				

There is not much material furnished for filling up in working this seam; the principal of the debris stowed in the stalls is obtained from re-cutting the bottom in the roads; this requires constant attention, from the tendency of the bottom to puck. Timber is largely used; the stall roads are double timbered; the headings and levels have a succession of strong double timbers every 2 or 3 ft., let into the bottom. No powder is allowed in working this coal; it is got by wedging. The coal is required to be holed under No. 2 with the pick, as there is no parting there. Clanny lamps are used by the men, and by the agents, the firemen in their examinations use the Davy; Clannys are preferred, not only for the superior light they afford, but in point of safety. The indications of the presence of inflammable mixtures are perceived as quickly on the flame of the Clanny as on the Davy lamp, the blue top showing similarly as on a candle. The peculiarity connected with the working of this seam is the prevalence of outbursts of gas, locally termed "bumpers;" several of these discharge daily at the faces of the working places with a loud report, rendering the use of good safety-lamps imperative, where the safety of the mine is so dependent upon the principle of the safety-lamp. The gas is supposed to be lodged in the rashes above the coal, in a state of high compression, and by the cracking of the top coal the men are warned before the gas discharges itself. The place may be fouled four or five yards back, more or less, as the "bumpers" vary in the amount of gas discharged. Notwithstanding the frequency of their occurrence, no life has been lost from explosion since the colliery was opened, nor has any serious explosion occurred; it must be admitted the discipline of the mine must be very stringent, and the colliers careful and steady in their movements, otherwise this result could not have been attained. This colliery has been the subject of other incidents. When first opening out the workings were flooded with water; in pumping the water down to the level of the coal the pent-up gas thus liberated found its way to the top of the pit and exploded at a lamp there, and extended down into the mine. During the Monmouthshire strike, in 1867, which extended over a period of 17 weeks, the ventilation of the mine was suspended, because no one could be found to attend to the furnace, and the mine was filled with carburetted hydrogen gas; the ventilation, at the termination of the strike, was restored by a waterfall in the downcast, and by opening doors the gas was removed in sections, without any accident; the gas was plainly visible issuing at the top of the upcast stack.

VENTILATION.—There are two furnaces, placed about 20 yards from the bottom of the upcast, one 10 ft. wide, one 8 ft. wide; bars 9 ft. long. The furnaces are closed in front with perforated doors; they consume 20 tons of coal in 24 hours. This is equal, on 90,000 cubic feet of air per minute, 3000 cubic feet per 1 lb. of coal used. The distribution of air is as follows:—

To the west side of the pit, unworked	Cubic feet 18,000
To the stables	12,000
To the east side of the pit	60,000=90,000

There are nine men employed at the furnaces in 24 hours—

One firing each	2	by day		2	by night.
One unloading coal at each	2	,,		2	,,
One overlooker	1	,,			

The main return, on the south side of the engine-plane, and parallel with it, is also the travelling-way for men and horses. The whole of the air from the south and east districts returns through it. It has been enlarged throughout; its average size may be 8 by 8 ft.=64 ft. area. A current of 60,000 cubic feet would give a velocity of 16 ft. per second in this air-way. As there is a probability of this return becoming explosive, even at the high velocity named, it is highly important to have in use lamps capable of bearing a current of 25 ft. per second, at least, without exploding. What has occurred once may occur again. There are many instances in other mines of the returns being fouled by gas thrown off at the goaves. The velocity of the currents, we may fairly assume, would be 8 ft. per second at least, so that it is absurd to suppose a Davy lamp which passes flame at that velocity would be safe. We hear with satisfaction that preparations are being made for erecting one of the largest Guibal fans at the top of Abercarn upcast pit, and then removing the furnaces. The fan will be 40 ft. in diameter, 12 ft. wide; two engines of 30-in. cylinders will be erected, either one of which will drive the fan; the other may be attached at any moment. This fan will not only produce a larger circulation of air, but in other respects will increase the safety of this mine. In superseding the furnace many risks will be avoided, and a saving of coal and labour effected. There are 37 horses employed underground. The trams are both open and close bodied; the latter are preferred, as the roads are kept cleaner with them. The wheels are for tram-plates, 14 in. diameter; plates 3 ft. long. Mr. Llewellyn, the manager of this colliery, contends the tram-plates are best adapted for roads which are continually pucking. Long rails would, no doubt, be unsuitable in these cases, but short lengths for the workings and longer ones for the engine-planes and main roads would, I contend, be an improvement. The Clanny lamps are obtained by the owners from one of the best makers in the North of England. Each workman is provided with one of their lamps, without charge, only in case of breaking the glass the cost of a new one is charged to the user of the lamp. About 250 persons are employed underground by day, in cutting coal, &c., and 150 by night, in repairing, cutting bottom in the roads, and stowing up in the stalls: 100 coke-ovens are erected at Abercarn for coking the small coal; the ovens are charged at the doors. The coke is drawn out by movable crabs, and bars inserted before the coal is put in. Each oven has a short chimney, and counter-weights are provided for the doors: 500 tons of coke are made per week at present from 80 ovens. The coke is principally exported to foreign parts.

Nov. 9. M. B. GARDNER.

IMPROVEMENTS IN IRON AND STEEL.

SIR,—I read with great interest the article in last week's Journal upon Improvements in Iron and Steel, in which is stated what has been done by M. le Baron Gruner as to improvements in the Heaton process. M. le Baron has, singularly enough, hit upon precisely the same method as myself for preparing the iron previous to its introduction into the converter, and for which special process I have obtained Letters Patent. I convey this information, as I think it may be interesting to your readers, as further evidence of distinct people, in different countries, arriving at the same results, without any previous knowledge of each other's labours. ALBAN MEREDITH.

Clement's Inn, Nov. 10.

THE WELDING OF RAIL IRON.

SIR,—When I learnt that an Iron and Steel Institute was to be established for the advancement of these branches of industry I had hoped that all or any intelligent operatives would be invited to participate in the accruing advantages, but I sincerely regret that the rules and charges for membership altogether prevent the admittance of this class of men. To an individual of my sphere of life it seems passing strange that our leading ironmasters should exhibit such tardiness and apathetic coolness towards the advancement of art and industrial education amongst their various workpeople, for not only is it a well-substantiated fact that such education renders the operative more competent and trustworthy in his duties as a skilled workman, but at the same time enables him to become a better citizen and member of society, by ennobling and strengthening his ideas and conceptions appertaining to matters concerning his own existence and the physical laws relating thereto. Let employers only give a passing thought as to the indifference displayed by the majority of those in their employ as to the essential elements required to sustain life and manly vigour, or as to how the most vital and important gases are so frequently contaminated by the many poisonous elements of which they themselves are the originators. Only observe how we trifle with elements of the most destructive character both to life and health; how complacently we trust our persons with, as it were, ignited torches in our own hands amongst open barrels of powder, and how many are daily carried from time into eternity through carelessness and want of sound practical knowledge of the limits and power of the elements they have daily to contend with and labour and live amongst. Indeed, it is quite an enigma to me, seeing the daily record of the destruction of human life from want of this education, that our employers should remain so cool and indifferent to the interests of those who by their toil have reared England to her present opulent and distinguished position amongst the nations of the world.

However, the first meeting of the Iron and Steel Institute is now over, and it appears to me that unless there were something more useful and impressive transacted at the meeting than appears from the published reports, the mountain convulsed in labour and producing a mouse has been truly exemplified. It is quite evident, from the tone of many of the agents representing extensive steel and iron making firms, that they are very desirous to confine their rail making operations to steel alone. Of course, when we look for the solution of this desire we find it in the fact that there is less manual labour and more machinery employed in the production of Bessemer steel than in the production of wrought-iron, consequently skilled workmen can be almost wholly dispensed with. This species of steel is produced, moreover, with a greater degree of certainty and regularity than is at present the case with wrought-iron, the elimination of the carbon in the converter being dependent on the pressure of blast, and the limit of time required for the forcing of the same through the molten mass. Thus, it can be computed almost to a second of time, and the amount of carbon sought to be eliminated depended upon. Again, the reheating of these ingots, preparatory to being converted into rails, is dependent on the period of time during which they are treated, and not upon the skill of the operative.

Now, it occurs to the reflective mind that this punctuality and dependence in the production of steel ought to have suggested the same thing in iron making. Steel having almost mathematically demonstrated the requisite conditions for the elimination of the required amount of carbon, why cannot the boiling of pig-iron in the puddle-furnace be made subservient to the same rules? As regards the boiling of grey pig in particular, I believe it is a very expensive mistake to boil it in such a vast mass of fluid cinder—or bath of cinder, as it is called; and this was the opinion of the late Mr. Anthony Hill, of the Plymouth Iron Works, Merthyr Tydvil. It was at his works that the iron which forms the links of the cable of the Great Eastern were made, and their toughness and compactness unmistakably demonstrates the quality of the alloys composing them, for it has been represented that some of the links stretched ½ in. whilst holding the ship at anchor, yet did not part; and it should be borne in mind that the alloys composing these links could only have been produced by observing nearly the same mathematical precision as is at present observed in the production of steel ingots—excess of any element must prove equally fatal to the production, Now, this most excellent iron never boiled higher than that which is required to boil refiners' metal—that is to say, without the assistance of the bath of cinder, which must tell so heavily against the profits in ironmaking, in consequence of the enormous expense of fettling. I have oftentimes felt much astonished in witnessing the amount of material that has been amalgamated with the puddle-bar, in the shape of fettling that did not contain one atom of oxydising matter, but had compounds of silica and sulphur. I wonder that it has not more frequently occurred to the minds of ironmasters to estimate what it costs them to oxydise a ton of marketable bars. There has been a great deal of high talk respecting how to economically carbonise a ton, and no doubt it is pretty well understood how much coke or coal is required for this purpose; but I presume it is yet an unsettled question as to the expense per ton of oxydising either iron or Bessemer steel.

Again, as regards the cinder tapped from these baths, I have seen a number of these taps analysed, both raw and calcined, and in neither case has there been a trace of oxygen discovered. It has been observed that the best qualities of hematite ores are undoubtedly a very superior and efficient fettling, but the inferior qualities hold too much silica and too little iron, and consequently will not stand the heat of the puddling-furnace, but readily melt down into cinder. Indeed, the very best of this ore is too liable to this easy fusion, and it may be further observed that ores of whatever kind they may be containing less than 50 per cent. of metal, however beneficial to the quality, are hurtful to the yield. These facts being admitted, how does it happen that a fettling which produces a mere waste of tap is so much persisted in? Have not practical analytical chemists long ago defined what are, or ought to be, the atoms that constitute either cast or malleable iron suitable to any demand or commercial purpose? Why, I repeat, should these destructive and poisonous alloys continue to be used, when we are told that even the most suitable of the hematites cannot withstand the temperature which must be brought to bear on the fused or wrought iron? So that there is not only a waste of tap, but there must be a very decided effect on both quantity and quality, as the excess of silica prevents oxydation; for it is well known to all practical ironworkers that unless in the puddling department the worker can adapt the cinder requisite to produce the desired chemical change to the character and stamp of the iron, he at once loses all control in the production of either quantity or quality. I believe it is with the utmost difficulty that fluid silica can be oxidysed at all. Some experimenters have told us that they have accomplished this, but then there are various and numerous modifications of that matter, containing, no doubt, various other elements, so that our practical assayers would do us some service if they described the sample that they have succeeded in oxydising in a fluid state, and whether such samples are mostly to be found associated with the iron ores of this country. If many of our present ironmasters would turn their attention to the difficulty there is to contend with in oxydising the various products together, the immense waste that daily and annually results from the introduction of an ingredient that produces a waste tap would be prevented.

Now, those acquainted with the mode of iron manufacture carried on by the late Mr. Anthony Hill are perfectly aware that the only fettling ever used by that gentleman was simply fire-clay. There is much reason to fear that too many of our ironmasters, in studying the commercial aspect of their calling, neglect the practical and chemical considerations connected with it, and to this no doubt might be attributed the repeated failure of so many joint-stock companies engaged in iron making in the principality of Wales. No doubt many inventors have led the producers of malleable iron into very sanguine and hopeful expectations that ere this puddling could be accomplished by some mechanical development, and thus have drawn away a great deal of attention and talent that would otherwise have been brought to bear upon this branch in studying how the various products could be most conveniently oxydised. Mr. E. Williams, of Middlesborough, read a paper before the Iron and Steel Institute on the Malleability of Iron, and stated that in his extensive experience of iron rail making the greatest difficulty yet to be subdued was how puddle bar could be rendered as compact and homogeneous as steel when rolled into a rail. No doubt Mr. Williams has been sorely tried in the matter, but then it occurs to me that this gentleman, with all his vast experience, has omitted to direct his attention to the origin and exact causes of his failures.

We will begin at the beginning—that is, the metallic bases, as it is a well-known fact that in many places these are anything but what they should be, so that adherence to either quantity or quality is out of the question. The further consequence of this negligence is uncertain fusions from the blast-furnace—some of these fusions contain, probably, from 10 to 40 per cent. of carbon more than others, and very likely the same thing might be said respecting sulphur, phosphorus, and silica. Of course, it would puzzle a clever chemist to define the quality and quantity of the various elements in these uncertain fusions. Again, the low percentage of carbon in some of these fusions will scarcely allow the pig to become fluid at all in the puddling-furnace, so that the only ingredient that can assist this operation is a fluid cinder, or a cinder that will melt at a very low temperature, and this is a cinder highly impregnated with both sulphur and silica. Now, instead of trying to husband the carbon by properly alloying these various products, they are invariably run at random into the puddling-furnace—one charge will boil like a volcano, whilst the next is the opposite extreme, and cannot be made to have any action at all, consequently, the pigs being as variable as the days of the year, I should like to know how these various products can be properly cemented and amalgamated with each other. In the heating process there are, probably, half-a-dozen pieces, requiring as many different degrees of temperature. These pieces of puddle bar from which a moderate percentage of carbon has been eliminated require twice or thrice the temperature necessary for those that had to depend for their fusion on siliceous fluid cinder. If Mr. Hill had neglected this important matter the esteem in which his iron was held would long since have shared the same fate as hundreds have already met through encountering the difficulties of this treacherous flood. Just suppose for a moment that the pig sought to be converted into steel were thus fused together at random. What would be the result? Why, a parallel to what is daily experienced in iron rail making.

Nor does the difficulty end in the proper alloying of these uncertain fusions. Just consider the structure of the heating-furnace, and its powers in giving the pile a uniform temperature from one end to the other. Only observe the various degrees of temperature the several surfaces of the pile presents. See how it twists and contorts itself in the rolls, from the absence of an equal heat throughout the mass. But it might be remarked that this is all due to the negligence and unskilfulness of the workman, and this in a great part is the fact, but it arises because there is very little understood as to the amount of free oxygen that must pass over and around each fagot, in order to render possible the cementation without reproach. Many of these furnaces are built to give a high rate of temperature in the shortest possible time, so that the flame instead of penetrating the mass flies over it at telegraphic speed, burning one surface and starving the other. To render these surfaces equal in temperature, it is necessary that the pile should have a rotatory movement, like the roasting of a goose. Steel requires no such heat, nor does iron either, but it must be remembered that the flame cannot be made to reverberate too much, in order to render the ingots of steel soft and pliable, whilst many of these heating furnaces are so constructed that if the pile were in them until domesday there would never be enough heat near the bottom to cement the iron at that part of the furnace, and I hope Mr. Williams will just give a little of his time to study these hints. In a future letter I will again refer to this subject.

Merthyr Tydvil. A PUDDLER.

ON THE ASSAY OF SILVER ORES—No. II.

SIR,—In my last letter I insisted upon the necessity of distinguishing between assays made upon small fragments of ore and assays made upon 1 ton or more of material. The former results cannot logically be stated *in tons*, since the material from which the sample was taken does not amount to 1 ton. I believe that I am the first to point out this distinction, though the subject of the assay of picked specimens was, if I mistake not, alluded to some years ago in the Journal; and it cannot be too much insisted upon, otherwise a careless manner of stating results of assays is acquired, which is far from scientific, and can only lead to error.

Another subject which is, perhaps, worth a passing notice is the relative value of *dry* and *wet* assays, as regards silver ores in general, or argentiferous ores of other metals not uncommon in this country. About ten years ago I was led to the conclusion that when both descriptions of assay are made with all possible care, there is no appreciable difference in the results; if there be any difference, the wet method is, perhaps, rather the more delicate and more accurate of the two, but it can only be applied to certain varieties of ores without considerable difficulties, whilst any description of ore can be readily treated by the dry method. I formerly undertook, in Paris, a series of experiments on this subject in the laboratory of my excellent friend and distinguished mineralogist, Prof. Pisani, who was, shortly before, first assistant to Charles Gerhardt, and himself the author of an ingenious volumetric method of assay, to which I shall refer in a future letter. Numbers of specimens were assayed by the two methods, the dry and the wet, principally with rich Spanish fahlerz, and the results were in every case so nearly identical that the differences rarely affected more than the second decimal.

On the other hand, I have little or no faith in the *quantitative* assay of silver ores by the blow-pipe method. Not that this method, as described by Plattner, and perfected by others, is not highly ingenious, extremely useful, and capable of yielding remarkably accurate results in the hands of those who have given it a very great amount of practice; but though I have myself had some experience with this method, and never travel without the requisite apparatus, I would not trust to it for the quantitative assay of any siver ore from a working mine. With rich picked specimens the results are perfect, but when the amount of silver does not exceed 25 ozs. to the ton, I should never count upon its accuracy. Even with a much smaller amount of silver, Plattner's blow-pipe method is a most invaluable aid to the mineralogist, enabling him to detect the presence of silver and gold in various rocks, with comparative ease and in a short space of time. I have used this method again quite recently for quantitative assays, and have obtained little buttons of silver, with English gossan, that contained only 6 ozs. of silver to the ton of material. The little button in such a case is quite visible to the naked eye, and easily visible with a lens.

In spite of the numerous experiments that have been made within the last 25 years upon the application of electricity to the chemical arts, it has not yet found its way into metallurgy, properly so called. Though the electric current cannot, as some have supposed, be made use of satisfactorily in the assay of silver or copper ores, it is by no means certain that it will not, some day, be found an advantageous method for extracting silver from ores containing only 20 to 50 ozs. of precious metal per ton. I cannot help thinking that those ores which contain silver in the state of sulphide, dispersed through a vast amount of quartz and schist, might be made to yield thin silver to a solution capable of conducting the electric current, and might, perhaps, be successfully worked on a large scale by such a process. I purpose this winter to turn my attention to the subject, so of this more hereafter. T. L. PHIPSON, Ph.D., F.C.S.,
Member of the Chemical Society of Paris.

Analytical Laboratory, Putney, S.W., Nov. 9.

ON THE ASSAY OF SILVER ORES.

SIR,—Under this heading, in last week's Journal, is a letter signed "T. L. Phipson, Ph.D.," and whilst professing to be an impartial criticism on the usual method of assaying ores, is unfair in the insinuations thrown out respecting a mine and its silver ores, which your correspodent admits he knows nothing whatever about. Although he has not mentioned names, yet it is plain to all that "Old Treburgett" is the mine to which he refers, as no other "old Cornish Mine" is before the public containing such ores.

Your correspondent would wish to impiy that the assay of over 3000 ozs. of silver to the ton is likely to mislead, and that no proper samples or proofs of the value of a ton of ore from the mine have been laid before the public. On reference, however, to the prospectus, or the advertisement of Old Treburgett, in the *Mining Journal*, it will be seen that the above-mentioned assay is expressly stated to have been made upon "*a specimen of pure silver ore*," picked up at the mine by Mr. David Forbes, F.R.S., and given as a proof of the existence of *true silver ore* in this mine. In order to determine the *commercial value of the ore, one ton was sent to Messrs. Betts and Son, silver smelters, Birmingham*, who found it to contain silver to the value of 28*l.* per ton, a most satisfactory result, especially when it is remembered that the ore had not been submitted to any previous dressing, but merely hand-picked by men totally unacquainted with such ores. When properly dressed for market, every miner knows it must necessarily yield a considerably higher percentage of silver. The lead ore was treated in the same manner, and Messrs. Bath and Co., Swansea, sold it at the rate of 24*l.* a ton.

As Dr. Phipson now considers it a *sine qua non* that an assayer should always state the bulk from which his assay has been made, I shall in future regard with some degree of interest all published accounts of your correspondent's assays of ores.

In conclusion, I may state, so far from making use of "waistcoat pocket" specimens, every facility has been given for the examination of the mine and its ores, as seen in my letter published in the *Mining Journal* of the 10th of July, 1869. T. A. MASEY.

The Temple, Oct. 10.

RICH SILVER ORE IN CORNWALL.

SIR,—I am instructed by the directors of the Old Treburgett Silver and Lead Mining Company (Limited) to call your attention to the letter of Dr. Phipson, on the Assay of Silver Ores, which appeared in the Supplement to last week's Journal.

The directors complain that your correspondent, in alluding to what is announced in the Journal of Oct. 30 concerning Mr. David Forbes' assay of ores obtained from this mine, has trespassed beyond the fair bounds of criticism, by stating and warning the public that such announcements "are utterly worthless."

On referring to the company's prospectus in your Journal of Oct. 30 it will be seen that it is distinctly stated the assay was made from a specimen of pure silver ore, and further that, in order to test the commercial value of the ore, 1 ton in its undressed state was sent to Messrs. Betts and Son, silver smelters, Birmingham, who found it to contain silver to the value of 28*l.* per ton, which fact your correspondent quite ignores.

The directors are at a loss to account for the animus which prompted Dr. Phipson, under the pretext of protecting the public interest, to depreciate the value of the company's mine, and I have applied to him to withdraw or modify his letter to you; but, should he not do so, I must request that you will do justice to the company in the next number of your valuable Journal, as Dr. Phipson's letter is a libel, and calculated to injure the company. J. D. KEIGHLEY.

Basinghall-street, Nov. 9.

THE ASSAY OF SILVER ORES.

DR. PHIPSON, AND OLD TREBURGETT.

SIR,—Dr. Phipson seems to have been stirring up a deal of dust about nothing. The statement he alludes to, made in the prospectus of an "old Cornish mine" about to be re-opened—that a specimen of pure silver ore picked up at the mine gave an assay of 9·96 per cent. of silver, or over 3000 ozs. per ton, could not possibly have been made in order to deceive, or to lead anyone to adopt the extravagant notion that the gross produce of the lode was of this richness, as Dr. Phipson's virtuous and indignant protest would seem to imply. For if the promoters of the company had any such design in making this statement, they would have stultified themselves by that made in the very next paragraph, wherein it is stated that 1 ton of the silver ore, sent in its rough undressed state to the smelters, was proved to be worth 28*l.* If, then, anyone had been so simple as, on reading the former statement, to be led into so egregious an error as the Doctor thinks the investing public would be, he would here find the immediate and complete corrective of his error. The statement in question is made simply to show the richness of the "pure silver ore" found in this mine, and whether this richness of the ore be expressed by percentage, by the number of grains to the ounce, or the number of ounces to the ton, matters, I imagine, but little, as long as we credit the public generally with a sufficient modicum of common sense and elementary information as to understand what these terms mean. The Doctor candidly confesses his ignorance of the mine, and of its claims to consideration, and then somewhat naïvely and inconsistently states that probably there is not ¼ cwt. of this rich silver ore in the whole workings of the mine.

Surely, Sir, we may here appositely quote the proverb, "*Ne sutor supra crepidam*," or "Let the cobbler stick to his last." We may, perhaps, be willing to admit the Doctor's evidence in the matter of an assay, of which he is presumed to know something, but really it is rather too much to ask of us that we should take his evidence in a matter on which he professedly declares his ignorance. For the consolation of those who are interested in the mine, I may state that upon fair evidence—the evidence of those who have long been acquainted with the mine, who have worked in it, and, therefore, do know something about it—we may reasonably conclude that there are "probably" even very many tons of this rich silver ore existing in the old workings; and, further, that from the expressed opinions of scientific men—not professors of the blow-pipe, but of geology and mineralogy—we are supported in the belief that rich silver ores will increase in richness and quantity the deeper we descend upon the lode. I would remind the Doctor, moreover, that there is a difference between a "picked specimen" and "a specimen picked up" at the mine; the former phrase would mean a specimen carefully selected from out of many, the latter phrase may mean a chance specimen met with without careful and diligent searching, and, if I am rightly informed, such specimens as the one in question are readily met with at the mine. But the value and merits of the mine do not rest upon the existence of this pure silver ore alone; it is lead ore, which in the former working of the mine gave a large return of profits, even at 7*l.* or 8*l.* per ton only, has now been proved from its richness in silver to be worth 24*l.* a ton at least; and that, let me remind the Doctor, not from the assay of a "picked specimen," but from the legitimate smelting of a whole ton of ore. MIND YOUR P'S AND Q'S.

MINERAL WEALTH OF SPAIN—No. III.

SIR,—In my former letters on the Mineral Wealth of Spain I gave you only a mere outline of the mining and other commercial resources of the country, I will now give you a short account of the first modern iron works erected in Spain, and their progress. In or about the year 1829 there was discovered near to the town of Marbella, a small city about 10 leagues from Malaga, in the South of Spain, a valuable lode—in fact, a mountain—of magnetic iron ore. Upon its discovery various devises were resorted to in order to give it a commercial value. The Catalan forges were tried, at great expense, and failed; but the fortunate discoverers, in those primitive days with the Spaniards, possessed convincing proofs that the mineral was valuable; consequently the matter was taken in hand by Dr. Manuel Augustien de Heredia, a rich and influential merchant of Malaga, who prudently and wisely dispatched some of the ore and a little iron to England, in order to test its quality and value, where a portion was manufactured into small size merchant iron and steel; and in order to test the quality of the steel it was manufactured into cutlery, such as knives, forks, razors, &c., which proved of superior quality. The result was as anticipated; thereupon a Spanish engineer of the Royal Artillery was dispatched to England, in order to confer with some manufacturers of note on the subject of erecting modern iron works near to the mines, and stipulate for the necessary machinery. It was decided to send out to Spain a small works complete, with properly qualified engineers and workmen to erect it, to make iron from two charcoal furnaces of modern construction, previously erected at the Rio Verde, near to the town of Marbella, where all the machinery was driven by water-power, but finding the water not sufficient for the whole of the works in the dry season, it was determined to transplant the works to Malaga, where magnificent modern iron works have been erected, consisting of five blast-furnaces, with forge and mills in proportion to the make of iron, forming an aggregate of about 300-horse power, and which are now being carried on with great success by the much respected sons of the late Dr. Manuel A. de Heredia. There are other iron works in Spain, but none equal in magnitude to these works.

There are other provinces in Spain where magnetic iron ore has recently been discovered, that have come under my notice, containing from 60 to 80 per cent. There is an immense bed of magnetic iron ore cropping out, in some parts of the mine, to nearly 5 yards high from the surface in the vicinity of Caceres, province of Estramadura, which upon an average contains 75 per cent., and could be made available by any enterprising capitalist. This is also free from any incumbrance, with limestone in abundance within 20 yards of the mine, and labour cheap. There is also coal in the mountain called the Serra San Pedro, in close proximity to the mine, but not yet developed, although I have seen sufficient indications to prove that coal abounds in the same range of mountains. I have taken some samples in the same vicinity, but very good coal from the mines of Belmez can be purchased cheap, and which are extensively used at the iron and lead smelting works of Messrs. Heredia, Malaga, and also by the steam vessels plying to and from the different sea ports on the Mediterranean. There is also good coal found in some parts of the mountain outcrops near to the town of Usarge, which is considerably nearer to the above-named iron mines of Caceres; consequently there is no difficulty whatever in respect to fuel, the only drawback being the want of capital and energy. But, like with many other things in that much abused and unnecessarily despised country, no notice has been taken up to the present time of such a magnificent mine of wealth.

There is another great and most important advantage connected with mining in Spain to persons acquiring mining property. The mining law is such that any person denouncing a mine, by giving proper notice to the Government authorities, and when the demarkation is made by the Government district surveyor, the property in the mine becomes perpetual, by payment of the small Government contribution. No royalty is paid for such acquisition of mining property, or demanded by the landed proprietor, consequently any person can acquire valuable mining property for the small outlay of about 10*l.* Such is the great facility offered by the new law instituted by the Spanish Government to invite speculators and manufacturers to develope the mineral wealth of the country.

The ancient Catalan forges are fast disappearing in Spain before more modern appliances. Recently a few have endeavoured to remodel their small works, but they are few and far between. In the whole of Spain there is not one modern manufactory of steel: they still retain their primitive mode of making that most useful article, leaving a wide field open for some future enterprising capitalist to make a splendid fortune. Now, the most remarkable circumstance is that the Scotch appear to take the lead in nearly all modern discoveries. About three years ago one of that canny race discovered a valuable coal mine a few leagues from the important sea port town of Malaga, which is now in full operation, and working to great advantage, under the title of the Spanish Coal Mining company (Limited); and, from the latest account I have received from the South of Spain, the company are in a most prosperous condition, with splendid prospects before them. They are now laying down about two miles of rails, that will intersect the whole system of rails to all parts of Spain: yet, in the face of all this natural wealth in the country, and the easy terms the Government offer for capitalists to invest in manufactures or mining, and the undeniable fact of the known prosperity of many speculations in the country, English capitalists, as a general rule, look upon investments in Spain with unnecessary suspicion. No doubt much of that arises from the fact that some of our capitalists have been indiscreet in their speculations in some of the non-paying railways in Spain; but the English or any other capitalist should take into consideration that Spain is comparatively a primitive country—a splendid country, but notoriously neglected in former times. Now, to make railways remunerative in any country there must be manufactures, which bring in their train commerce, and commerce engenders speculation. Any intelligent person can see at a glance, by reading the preceding remarks, where and how to find good and sound undertakings. It must be acknowledged that English capitalists have had ample experience recently of railway matters in England to convince them that it requires the greatest amount of prudential wisdom to know which are the best and soundest undertakings to invest in, without reflecting on Spanish railways. You may take it for granted that the time is not far distant, when the country is more settled down to its normal condition, which it is now fast doing, when commerce will flourish and expand into its usual channel, and trade will then increase to an unprecedented extent, and the now desponding shareholders will then have cause to feel grateful, and be amply repaid for the detention of their dividends; particularly when the vast area of the rich wine-growing districts are properly opened out, when the merchants will have the much desired opportunity of transporting, not only wines but other agricultural produce, by rail, which is much needed to properly develope the general commerce and manufacture of the country. If the British Government could be induced to reduce the heavy duty now paid on the high-class wines of Spain, the traffic by rail with that commodity alone would be enormous, and the wine-consuming community would then have a better opportunity of tasting pure wine from the grape, in place of the vile compounds that are sold in England and elsewhere as sherry.

Respecting lead mining in Spain as a safe investment, the following can be relied upon as a fact. In or about the year 1844 the important discovery was made of the rich silver-lead ore of the Sierra Almagrera, near the town of Granada, which contained the unprecedented quantity of 27 ozs. of silver to the quintal of lead; and the carbonate of lead ore gave 16 ozs. of silver per quintal. At the time I was engaged at the lead and silver extracting works at Adra, the property of the Messrs. Heredia, Malaga, they were extracting from 8 to 10 quintals of silver per week, and the works still continue in full operation, though not at present producing so much silver, in consequence of the lead decreasing in quality. Besides silver, they produce sheet, shot, pipes of all dimensions, and white lead. Notwithstanding the works are very extensive, it has been found expedient to erect other large lead smelting works at Malaga, contiguous to their extensive iron works. There are a few small lead works in Spain, including one recently established at Linares, but nothing equal in size to those of Messrs. Heredia. So important are the late discoveries of rich lead ores in many parts of Spain, that small companies have been formed for mining only, but nearly all have failed, from the want of sufficient capital and practical mining knowledge. The same may be said of the rich silver mine recently discovered near Tunkillo, province of Estramadura—the most extraordinary deposit of lead ore that ever came under my notice. When on mining business in the neighbourhood I visited the mines, and examined the workings. The lode then measured 1 metre wide and about 2 metres deep; but at the time of my visit it was not cut through. It then yielded over 40 ozs. of silver per ton; but, unfortunately for the small company of native shopkeepers who now hold the mine, they have neither capital or mining knowledge to aid them, and must of necessity soon collapse; indeed, they offer the whole concern to any enterprising party at very moderate terms. There are other mines in the same locality, some actually opened out in working order, but, like their numerous predecessors, abandoned, and from the same cause. There is ample scope in the same district for some enterprising capitalist to erect lead smelting and silver extracting works to great advantage, for nearly the whole of the lead ore extracted is forwarded, and sold as per analysis, to the lead works of the Messrs. Heredia, Malaga; and in many instances, where there is confidence, money is advanced to the miners, who could not possibly work the mines without such accommodation.

The few preceding remarks I have made on the mineral wealth of Spain, assisted by your kind indulgence, I hope may prove of some advantage to parties interested in safe and good sound undertakings in a country that is second to none in the world, where fortunes can be made, and where religious tolerance is now granted all over the country with perfect freedom and protection to all, the press free, and all unanimous in inviting the British capitalist to come to that splendid country.

In next week's Journal I will, by your kind permission, give the text of a Bill which is now under consideration for further facilitating the development of the industrial resources of Spain.

Manchester, Nov. 5. B. H. HOWARTH.

MINING—DUTIES OF LANDOWNERS.

SIR,—Many abler than myself have been endeavouring lately in your columns to impress the minds of landowners with the propriety of considering more liberally their relation to the mining interest of this county. And a subject in which the interest of all classes is concerned can scarcely be too often alluded to and agitated if we wish to keep pace with the circumstances and requirements of the times. The more the subject is investigated the more apparent it appears that the capitalist who invests his money in speculative mines does so with an undue advantage to the lords of the setts. What moral reason is there that speculators in mines, after paying at the utmost rate for all lands which may be destroyed, and laying out enormous sums in trying to open mines to return interest for their money and to get back their principal, should be expected to pay any portion of the proceeds of their returns to the lords until they get something for themselves? And would it not, as a rule, be ultimately to the interest of the lords if they would forego mulcting dues, and allow the money to go towards the working capital, until the mine comes into a profitable state? This would greatly tend to stimulate and increase the spirit of speculation, which at the present time is so much required, and ultimately prove the most successful means of producing more permanent and good incomes to themselves and their families, and which would then be handed over to them by the proprietary with hearty good welcome, notwithstanding they had been the principal means of producing it, at great risk of impoverishing themselves and their own families.

There was a time in Cornish mining when the chances of quick and great successes were much greater than at present. Notwithstanding this, there is nothing amongst the numberless schemes which are before the public, or which can be devised, which offers anything like equal chances of success on grounds of fair play for all interested, provided ground for mining purposes, and circumstances connected with it, be fairly considered by practical men, and that all things connected with mining matters be carried out systematically and honestly. I believe that class of capitalists who resemble the old sort of mining men, who worked mines on the indications which presented themselves and the merits which they possessed, is increasing; but I am in possession of information from such gentlemen, as well as facts from my own practical experience, that greater concessions on the part of the landowners and their agents are necessitously wanted if the interest and welfare of this county is to be preserved from further decay. The landed proprietors of the county should not require the strong appeals made to them on this subject by the miner. They have through the miner obtained many a princely fortune; and their tenants have had work for their horses and men, and a good market for their produce.

"And if an invader wants to take their lives,
They have forty thousand underground, who will know the reason why."

May they be further induced from seeking a home in foreign lands, leaving their families behind, who may, perhaps, become a burthen to those who now can relieve them and benefit themselves. May our merchants, our tradespeople, and our shopkeepers be saved from its being known of their being in a state of insolvency, and may us all have a return of brighter and happier days. All this can be brought about if the land proprietors will only consult their own interests. Many thanks to some of them who have taken steps in this direction, and I hope they will continue to walk on till our wants are attained.

Uny, Lelant, Nov. 8. PETER EDDY.

[For remainder of Original Correspondence, see this day's Journal.]

FOREIGN MINES.

BRAGANZA GOLD.—The directors have advices from Mr. W. H. Richards, their superintendent, dated Rio de Janeiro, Oct. 8, advising his safe arrival, along with his staff, at Rio on the 22d ult. He also states that he has already dispatched his men to the mines, and that he himself expected to leave on the 10th, having completed all the necessary arrangements.

LUSITANIAN.—Nov. 2: The lode at the plat, in the 130, is worth 1 ton per fathom. The plat is now complete, and the men are taking down the piece of ground at the whim-shaft for bringing down the skip-road. At No. 79 winze, below the 120, the lode is 2 ft. wide, composed of quartz and ore, worth ½ ton per fm. At the winze below the adit, west of River Caima, the lode is 1 ft. wide, composed of quartz and country. We purpose now to drive a few fathoms in the 10, as at this depth we have a loose and orey lode, worth ½ ton per fathom. In the 130, east of Taylor's, on Basto's lode, the lode is 8 ft. wide, composed of quartz and country. In the 130, west of ditto, the lode is 2 ft. wide, composed of quartz and stones of ore. In the 120 east the lode is 4 ft. wide, composed of quartz and flookan. In the 120 west the lode is 1½ ft. wide, composed of quartz and a little flookan. In the 110, east of River shaft, the lode is 1¼ ft. wide, all of a dry flookan. In the 90, east of ditto, the lode is 2 ft. wide, composed of a mixture of flookan and quartz. In the 70 east the lode is 4 ft. wide, composed of soft, wet flookan and quartz. In the 70, west of slide lode, the lode is 1 ft. wide, yielding stones of ore. In the 28, west of the cross-cut, west or Perez' shaft, the lode is very small and unproductive, and the ground hard. In the 28 east the lode is 1 ft. wide, worth 1 ton of ore per fm. In the 18 west the lode is 6 in. wide, producing stones of ore. In the 18 east the lode is worth 1 ton of ore per fm. In the deep adit level, west of Perez' shaft, the lode is 6 in. wide, composed of flookan.—Carvalhal: At the incline shaft, below the 50, there is a branch at the shaft that yields stones of lead, but not regular. In the 50, east of incline, on great lode, the lode is 1½ ft. wide, composed of quartz, with spots of lead. In the 40 east the lode is 2 ft. wide, composed of quartz and stones of lead. In the 10 east the lode is 2½ ft. wide, worth 2 tons of lead per fathom. In the deep adit, on the north lode, the lode is 1½ ft. wide, composed of quartz and stones of lead and mundic.

PONTGIBAUD.—W. H. Rickard, Nov. 2: Roure Mine: The 80 metre level, south of Richards's shaft, is in a strong orey lode, worth ¾ ton of ore per fathom. The rise a little behind this end yields ½ ton of ore per fathom. The 60 metre level, south of Agnes' shaft, is unproductive. The 60 cross-cut east is in hard, sparry ground. The 20 metre level, south of cross-cut, on Virginie's lode, yields ½ ton of ore per fathom. The same level, north of cross-cut, yields ¾ ton of ore. The stollen south of whim-shaft yields stones of ore. The sinking of Paul's shaft from surface goes on very well; we hope some time in next month to effect a communication with the stollen end. Our stopes and tribute pitches have a little fallen off in value, on the whole, since last month.—La Grange: The 100 metre level, north of Nosky's shaft, shows spots of ore, in a large lode, composed chiefly of quartz. We have holed the winze from the 80 to the back of this level, which gives good ventilation. The 80 metre level north is in a soft, unproductive lode. We have one stope working in the back of the 80, yielding 1 ton of ore per fathom; and five tribute pitches in the different levels, yielding a fair quantity of ore stuff.—Mioche: The adit north is in hard, poor ground. The same level, on the eastern part of the lode, is in disordered ground; the lode is unproductive.—La Brousse: The sinking of Basset's shaft below the 100 goes on well; we hope to attain the required depth for a 120 metre level in about a month. The 100 north yields ½ ton of ore per fathom. The same level south is unproductive. The rise in the 80 south is in speedy ground; the lode is poor. The 60 south yields ½ ton of ore per fathom. The 40 north is in speedy ground; the lode is unproductive. The 20 south is in disordered ground. Our tribute pitches continue the usual good yield.—Pranal: The 70 cross-cut west is in pretty favourable ground; we hope to cut the lode in this month's driving. The 50 metre level, north of cross-course, yields saving work. The same level, south of Cohadon's winze, yields 1¼ ton of ore per fathom. The 50, north of cross-cut, yields 1½ ton per fm. Our tribute pitches throughout this mine yield about the same as during months past.—Surface: Our dressing has been carried on without interruption. The samplings were 238½ tons.

[For remainder of Foreign Mines see to-day's Journal.]

The Royal School of Mines, Jermyn Street.

MR. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR OWN REPORTER.]

Mr. WARINGTON W. SMYTH commenced his annual course of sixty lectures on Mining at the Royal School of Mines, Jermyn-street, on Monday last.

Mr. SMYTH (who was received with applause) said—In commencing a course of lectures on the Art of Mining, I have to-day to place before you a number of elementary points, which form a necessary introduction to the subject, inasmuch as the art of mining consists of a group of applications of science, portions of which, it is true, may be learned for the express purpose of mining, but which really can only be brought into actual practice by a long experience of a kind it is difficult to acquire at any other place than in the mine itself. Theoretical knowledge is necessary to abbreviate the labours of the student when he goes to the mine, rather than to make him ready for the actual exercise of the art at once. It has been questioned by some whether any amount of attention to lectures or of the study of books will be of real use to the practical miner; but there can be no doubt that the subject being based upon the application of a number of sciences, those who know most of those sciences will find in making themselves acquainted with the peculiarities and practices of these districts that they are able in any given place, and in a given time, to gain more intelligence than those who have not the same advantage at starting. The Art of Mining may be considered as an assemblage of processes by which the useful minerals are obtained from their natural localities, which sometimes are found at great depths below the surface of the earth, and at other times near, or actually reaching, the surface. Indeed, it is impossible to draw an exact line of demarcation between workings in the open day, or quarries, and mines worked by artificial light; and conflicting interests, in many cases, have only been reconciled by expensive lawsuits. Besides a knowledge of the best modes and means whereby the valuable minerals are obtained, a series of operations have to be carried out, chiefly by mechanical, but often by chemical processes, to render the minerals fit for market. The object of these operations or processes is the removal of impurities which would otherwise make the ores unsuitable for the work of the smelter. Indeed, in mining, there is a long series of processes which depend on the proper application of certain sciences. Thus, GEOLOGY is necessary to point out the nature of the substances or rock masses in which the mineral required has to be looked for and from which it is to be obtained. MINERALOGY is required to tell the character of the species and varieties of the minerals to be worked; and those students who have attended the classes on Mineralogy are aware that minerals, and more particularly the more valuable ones, put on such a variety of aspects that without a long apprenticeship no one can expect to attain any excellence either in examining or successfully treating minerals. Then the science of PHYSICS has to come into play frequently in dealing with two of the greatest difficulties of mining—viz., the removal of water which makes its way into the mine from the surface or from subterranean springs, and those which stand in the way of proper ventilation—difficulties frequently enhanced by the presence of noxious and dangerous gases, which can only be dealt with by a thorough acquaintance with the nature of those gases. Again, MECHANICS are requisite at almost every stage of mining, in a greater or less degree; but in almost every case the safety of the whole mine depends upon this science from hour to hour and from day to day in the successful building and maintenance of the necessary machinery for pumping and drawing, for propping and arching the levels, and in a thousand other ways—besides being of importance with respect to the capital required for opening the mine. It is not always physical difficulties which cause the greatest expense—in one mine the difficulties arising from water may be great as compared with another, or the depths to which it may be requisite to sink may be widely different, or the rocks to be pierced may be of very different degrees of hardness; but the mineral itself may occur in so disseminated a condition that large masses of veinstone or hard material may have to be removed, and a vast amount of engine power employed for that purpose. Sometimes a mineral may be sufficiently free from impurities to enable the miners to send it to market or sell it to the smelter at once. This is the case with a great number of iron mines. Indeed, the ordinary iron ore could not pay at present prices unless it could be sent away without any great mechanical preparation, and in the case of the more valuable hematite iron the sparry quartzose matter with which it is associated is readily detached by a blow with a hammer. If iron should ever come to be sold at higher prices it will be necessary to seek out other methods of preparing those iron ores which have more impurities in them than the methods now practised will remove, and which, therefore, are not now workable. Cases of this kind, however, always depend on the intrinsic value of the metal to be produced from the ore. Thus, while we see that scarcely any dressing machinery is at all needed in respect to some ores, as iron and copper, such metals as gold and tin have a habit, as it were, of disseminating themselves in minute particles through large masses of the veinstone, and then very elaborate dressing machinery becomes necessary. I may mention a case which lately came under my own observation of a mine which had at one time produced copper ore largely where the vein gradually changed its character, and produced tin in such quantities that the latter became more important than the copper. Copper ore requires but little dressing, but it was then found necessary to erect such a quantity of expensive machinery for the purpose of dressing the tin ore that 10,000*l.* had to be expended for that purpose, so that it was almost like opening a new mine. Adventurers must, therefore, be prepared for cases in which ore of a quality which enables them to sell it in large lumps to the smelter changes so much as to require dressing to a high degree of purity, and when it is disseminated in the veinstone to spend a great deal of capital. This is a matter of much importance, because the necessity of raising further capital often affects the whole constitution of a company. I will not attempt to enter upon the wide and vexed question of the amount of education desirable in those about to take a part in the management of a mine. It is a question which has had much attention paid to it, not only in this but in foreign countries. In the latter, however, there are reasons for constituting schools of mining and colleges and academies for mining students on a different scale to what could be recommended in this country. In our metalliferous districts mines are generally managed by men who have risen from the ranks, and have shown themselves able and skilful miners in those departments which require the greatest amount of practical knowledge and observation—viz., in cutting away the ore. I speak more particularly of the "tributers" and those who attend to the pitwork and the heavy pumping machinery. If our mines were grouped together in larger numbers, and if other circumstances could be taken into account here which come into play in foreign countries, a greater amount of education would be needed than is now necessary as a general rule in our mines. When special cases of danger have to be met, as in our fiery collieries, or when the workings are carried to great depths under adverse circumstances, then a superior degree of education is requisite. The reason greater attention is paid to this subject in foreign countries than in our own is that almost universally the minerals belong to the Crown or Government, and it is indispensable that there should be a corps of persons competent to deal with mining questions. Thus it happens that there is no country in Europe without its mining college or academy, of which the most famous are those of Paris, of Freiberg, in Saxony, and of Schemnitz, in Hungary. But in England the Crown has retained no rights over the minerals, except in the case of the nobler metals—silver and gold. The right to work minerals in this country goes with the surface of the soil, and the consequence is that the great bulk of the mining is in private hands. There is, therefore, no necessity for a body of educated men to look after the rights of the Government, and carry on the general business of what elsewhere is a department of the State. Modes of working are devised to suit each particular case, and, although they have met with a large amount of success, there is nothing with us like the legalised systems of the Continent. Attempts have been made to establish schools (as, for instance, in Cornwall, by the great liberality of Sir Charles Lemon, and also in the North of England, by Mr. Dewas), but they have not been so successful as to have developed into schools of note and wide-spread reputation. Two or three continue to hold their own, but their sphere of action is very limited. With regard to this Institution, it should be remembered that its establishment grew out of the admirable series of collections brought together during the progress of the Geological Survey in the mining districts, consisting not only of mineral substances, but the various implements, with models and plans of the modes in which the vast mineral wealth of this country is obtained. These were brought together in one building, and, when it was found that they attracted much interest, it was determined that a system of instruction should be carried out along with these collections. The persons most to be credited with this design were the late Sir Robert Peel, Mr. Hume, and the late Duke of Newcastle, who thought that so large a series of instructive objects ought not to be lost to the nation as a means of education. The collections upstairs, however, are limited within certain bounds. They represent British minerals and modes of working, and do not branch out into other objects of interest as the British and other museums do, and they are illustrated by these lectures, which are intended, as far as possible, to point out to students the means whereby our mining operations are carried on, and also those of foreign countries. We shall find as we proceed great advantages in comparing our own systems with those carried out abroad for the different conditions under which mining is carried on, and which I have already pointed out produce very different results. Thus, here we have generally a greater amount of energy and speed, the object being to get as much as possible out of a given place in a given time; but less prudence and forethought than in foreign management. In the vast mining districts of the Harts mines and of Saxony we find that, although there is slowness of operation, the mines are laid out so as to last a great length of time. This is done partly by judicious management, and partly because the profits are limited, and thus a reserve of capital is created, so that when they come to poor ground they are able to work on until they meet with fresh chances of success. If such a system had been generally adopted in this country many mines which are now closed might have been still at work, and flourishing. Something, however, between these two methods would be the most desirable. If the tenure of mine property extended here, as on the Continent, over a greater number of years, our mining practice would probably be greatly improved. It is only natural that adventurers whose interest extends over forty, or fifty, or sixty years should work in a different manner from those who have only so short a period as twenty years. Whenever it happens that our mines are worked under a long tenure the systems of management approximate more closely to those on the Continent. The rapid style of working is abandoned, and there are mines which have lasted for a century which, if those who worked them had not had a continuous tenure would not have lasted thirty years, and perhaps not even a dozen.

This brings us very naturally to consider the mode in which companies are raised in this country for the purpose of working mines. The constitution of companies, the rates of royalty paid, and the amount of capital raised, are all so different and so various that one can scarcely venture into the subject. It is, however, one which lies at the base of every mining enterprise, and, therefore, one which the student must not lose sight of. Anyone who undertakes the management of a mine either here or on the Continent, if it be worked with British capital, should make himself fully conversant with all these details. In our own country the number of mines worked by one individual is very small. As a rule, the risks connected with mining are so great that it is felt more prudent to divide them, and companies are formed of more or less magnitude on that principle. Indeed, any man having a large sum which he wished to invest in mining would only act with common prudence if he divided it between several undertakings, and did not risk all upon one. I am speaking now chiefly of metalliferous mines, because the case is different when we go to coal and certain iron mines. There the material exists in great bulk, and it becomes a mere matter of mechanical and commercial calculation as to how much can be cut away in a given time, and at what price it can be sold. On the other hand, in metallic mining the risks are greater, and are divided into a multitude of shares. The principle of Limited Liability now sanctioned by the Legislature has not operated so well as its advocates expected in the creation of confidence. It has, no doubt, led to the formation of many companies, but it does not, in the judgment of many practical men, at all improve upon the system previously in vogue in the old mining districts—viz., the Cost-book System. Certain customs have long prevailed which have been confirmed by the legal tribunals, and having all the force of law, are well suited to those districts, and are well understood.

The right to the minerals being vested in the surface owner, the question naturally arises over how large an area we can carry on mining. The two diagrams on the wall represent, the one a metallic mine (the Levant Mine, in Cornwall), and the other a colliery in the North of England, each on a tolerably large scale. In the former, we have a number of shafts, and pits, and galleries extending right and left from them, in which it is shown that some portions of the lode have been obtained, leaving other portions which were not valuable enough to make it worth while to remove them; while the latter diagram shows all the material worked away. The arrangement, then, with the owners of the surface must be widely different. In the case of a metallic mine the vein is followed along the surface, and we are anxious to follow it as long as we can, but in breadth from 10 to 15 ft. probably would be all that it seems to occupy; and, as in the Levant diagram, we have a long series of workings running in horizontal lines from east to west, but never going far either to the north or south. In a coal mine, however, the shafts being sunk and the bed reached, the area to be worked extends, as it were, on all sides, and the extent must be large enough to repay the large expenses of sinking shafts and erecting machinery, besides profit on the capital laid out.

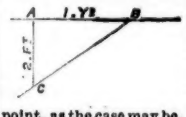
It is interesting and curious to trace the history of the rules and customs which have regulated mining from early times to the present. Great modifications have taken place during the last 300 years, and many customs which were then suitable, and have descended in one form or another to us, are often productive of much embarrassment. This has been especially the case with respect to the laws and customs affecting the respective interests of the owners of the minerals and those who carry on the work, and run all the risk consequent upon searching for and raising them from the subterranean depths. Three hundred years since the works were on a very small scale compared to those of modern times, although, it is true, some tolerably deep mines then existed, where the circumstances had been favourable and the difficulties small. If we pass to continental countries, and particularly to the Hartz district, we shall find that the same principles and practices as in this country were prevalent. A certain old writer, who went by the Latinised name of "Agricola," published a book 300 years ago containing a vast amount of information as to what was done in those days, illustrated by woodcuts of a remarkable clear character. He mentions that in laying out a piece of ground where minerals had been discovered, the first claimant had a right to go to a law officer and require a certain portion of that ground to be given up to him. This practice prevails to this day on the Continent and even in this country. If a person in Germany discovers a vein he fixes on a certain point at which to commence operations, and then he obtains what is called a "maas," a word which in Derbyshire and Yorkshire is changed into "meer," which is simply a corruption of the word measure. The first three portions he has for himself, the next goes to the King, the next to the Queen, and then the Master of the Horse, the Cupbearer, and other officers of the Court each come in for his share. Remnants of this old custom are still to be found in the Peak of Derbyshire and in some parts of Yorkshire, where if any person discovers a vein he secures by putting up a mark the right to get the mineral for 14½ yards on each side of that mark; that space being half a "meer." He has, of course, to call in an officer denominated the "bar master" (German, "bergmeister), and to make arrangements by which he is bound to commence working within a certain time. The reason of this custom, generally speaking, is that in the districts where it prevails the lodes make up to the surface, and they are very little troubled with water. Two or three men could, therefore, work on for years on a small taking of this kind. In places where water must be pumped out, or other physical difficulties must be met, it became necessary to grant larger quantities of land, so that the workers might find an adequate remuneration for the larger amount of capital and outlay that were requisite. The whole of this system, both in its smaller and larger proportions, has been worked out within the last few years in California and Australia. At first a hole 6 ft. across was all a digger could expect to obtain, and he had only to sink a few feet to come to the sand, gravel, or clay which contained the gold. As, however, the thickness of the overlying material increased, it was obvious that it would not be worth while, on an area of only 6 feet square, to go to large expenses in sinking to the requisite depth. Then another plan was adopted, which, however, depended a good deal on the distribution of the gold itself. It was found that the gold lay along a certain line, and then the grants took the form of so many yards of frontage towards that line. The miners, too, began to see the advantages of associated enterprise, and, joining their allotments, their capital, and their labour, often expended very large sums, and carried out extensive workings. At Ballarat, for instance, the Redan digging had shafts and works which cost 20,000*l.*, and the depth of the excavation was 350 ft. In this enterprise 80 adventurers were associated together, and within a few months they raised as much gold as sold for 70,000*l.* It is quite lately that similar arrangements have been rendered necessary by the discovery of gold in Sutherlandshire. At first great confusion prevailed, as no one knew anything of the business of gold digging. After a while certain fixed areas were allotted to the diggers, sufficient to give each a chance of extracting gold enough to pay for his labour. This Derbyshire system is carried out in Spain and Mexico with great regularity and advantage.

Supposing a person in those countries should find a piece of lead ore, for example, or the back of a vein containing lead ore, he could go to the authorities and obtain an exclusive right to work within certain limits, indicated by posts set up to mark the boundary. He would have to pay only such a fair amount to the owner, for damage to the surface, as might be assessed by certain official arbitrators. The system of "bounding" in Cornwall is another phase of this same practice. Any man there discovering a lode might take possession of it by turning over a few turfs at the corner of each piece of ground. These bounds were often left from father to son, or portions sold to someone else, and, perhaps, sub-divided again. Those who possessed these claims used to secure them by going out once a year, and renewing the bounders by again turning over the sods. These claims frequently become the subjects of lawsuits, as they not unfrequently included the surface, but all the other minerals. Juries, however, have invariably decided that where the workings had been interrupted for any considerable time the claim lapsed, and that it could not be maintained only by periodically turning the turf at the corners of the piece in question. I was under the impression that this custom had died out. It was found to be extremely inconvenient, and it interfered not only with the rights of owners, but with the enterprise of miners, who had capital and skill to bring to the work. No sooner would it be determined to commence a mine than these bounders would come in and claim such and such portions of the minerals. The system, however, is not wholly extinct, for I was myself present not long ago at the division of the profits of a tin mine, when the bounders came in for their shares, many of which were expressed by extraordinarily small vulgar fractions, so that it required unusual arithmetical skill to effect an equitable division. This curious relic of ancient customs, now doomed to speedy extinction, shows us that in the early times how difficult it was to push forward mining enterprise, and how anxious the more intelligent of our rulers were to foster that which they saw to be so very important an item in the future material interests of the country.

LECTURE II.—In our introductory lecture, said Mr. SMYTH, my object was to lay before you a few preliminary matters of importance before dealing with the nature of the minerals to be worked and the modes of working. I pointed out to you that the ownership of minerals was of a very different character in this and in other countries. From historical evidence, however, it is probable that in the outset the minerals were all reserved for the public service, the people being represented by their chief or king; and there was much reason in this, for the nature of the enjoyment of the surface is very different to the advantages derived from working the minerals below. In this country, however, grants of land to individuals and public bodies frequently carried with them supreme rights over the minerals, and so it came to pass two or three centuries ago that the question was legally settled, and it was decided that the absolute ownership of all metals except gold and silver should go with the ownership of the land. Some curious results have followed this settlement, for it has frequently happened, and, indeed, very often happens at this day, that a proprietor in selling the surface reserves his right to the minerals. Thus the surface owner often has to submit to the inconvenience of having mines opened on his land by persons living at a distance, who have acquired by purchase, or possess by inheritance, a right to deal with the minerals beneath it. This leads to great complications, which in Cornwall and South Wales are still more embarrassing, because the ownership of particular metals has been, and is frequently, disposed of separately. Thus it will be found that the tin belongs to one set of proprietors, the copper to another, and so on, and even each metal may be held by different individuals in fractional proportions, producing great awkwardness and hampering the miner by the difficulty experienced in bringing all these persons to reason with reference to the conditions under which they will allow him to work. Very much better for the miner are the circumstances under which the ownership of minerals exists in Germany, Spain, and Italy. There he has only two persons to deal with—the Government and the surface-owner. And the royalty due to the one being small, and the rate of assessment for damage done to the surface being fixed, the mining adventurer knows what he has to pay, and can thus commence his work with confidence and comfort. I have already stated that the "setts" as they are called in the metalliferous districts, or "royalties" as they are designated in the North of England, were in the early times of an extremely limited area, and that it was found necessary to increase these dimensions when the difficulties of mining rendered the employment of larger capital indispensible. Thus, in this country, instead of being confined to small lengths and strips of land, the setts are now bounded by the limits of an entire property, or with reference to selected straight lines or certain boundaries of fields. In these matters the greatest accuracy is needed in expressing in words or on a map the exact line of demarcation. In illustration of this point, I may mention that a lawsuit has been in progress for 10 or 12 years between two great Cornish mine owners with respect to a boundary line. The deeds specify simply that the line shall pass from a particular place to so-and-so's house, but it, unfortunately, omits to say whether the north end, the south end, or the middle. The consequence was that the right to work a considerable piece of the lode, which happens there to be very rich, became the bone of contention. If the line were drawn to the north end it would belong to one litigant, if to the south end to the other; and so the lawsuit goes on, to the great gain of the lawyers, and to the benefit of no one else.

The amount paid as royalty by those who carry out the works is extremely variable. This royalty is a certain proportion of the value of the minerals raised, and is either calculated in money, or is met by the reservation of a certain proportion of the ore dressed for the market for the lord. It is very important that this should be determined before any operations be entered upon. In former days, when mining was in its infancy, it was the general habit to fancy that a large portion should go to the proprietor, and that, without risk or trouble, he should receive a very considerable share of the profits won by those who embarked their capital, and took all the risk of the affair. In eastern countries the rapacious rulers claimed that half of the profit should be paid to them for permission to work, and the result was that nothing was done. When it is considered how great are the risks, and how much the anxiety and trouble of mining, it seems only fair that those who do the work should have the larger proportion of the profits. In this country a good deal of the old leaven still remains, and it was once not unusual in the North of England to give to the proprietor one-seventh, and in some districts even as much as one-fifth. But now that mines are no longer shallow, and difficulties have multiplied, a considerable modification of the royalty has taken place. In Cornwall the lord's "due," or "dish" as it is sometimes called, has been so much modified that at the present day the highest rate is one-fifteenth, and in the majority of cases one-twentieth. When particularly unfavourable circumstances occur, or when a commercial crisis lowers the price of metals very much, it is usual for the lord to reduce his due until the evil time has passed away to something quite nominal, as one-sixtieth or one-hundredth of the produce. In foreign countries some of the most forward in mining enterprise have greatly reduced the amount of royalty. In Prussia the miner used to be overwhelmed with a number of petty imposts, which, taken altogether, consumed a large amount of his profits; but these are now all abolished, and in their stead the moderate payment of 2 per cent. is required. In France and Italy the same liberal views have prevailed, and the probability is that these countries will by their liberality attract to them a large amount of mining capital, which in former days was employed in Great Britain. The difficulty of dealing in one undertaking with a large number of proprietors is also against this country, and contrasts very disadvantageously with the simple laws under which the large mining districts of the Continent are regulated.

I now approach the conditions under which the valuable minerals which we desire to obtain are presented to us. If these minerals were diffused equally through the rocks the greater part could not be worked at all, but they are providentially concentrated in bands or strata, and in deposits of other forms. It is highly necessary that you should have an intimate acquaintance with the forms of these deposits, and this pre-supposes a knowledge of geology. For without that it is impossible to get a clear idea of how they occur, and the accidents which may have happened to them. The history of the formation of these deposits will be brought before you by Prof. Ramsay in his course on Geology, but there are a few points which may appear to trench a little on the subject which I must place before you. Thus, I must mention that the bulk of the rocks of which the crust of the earth is formed are divided by geologists into two principal classes:—Those which are placed one upon another in strata or beds, and those which are not; the one being called stratified rocks, and the other unstratified or crystalline. [The lecturer then, by means of Mr. Sopwith's ingenious models, of which there is a fine collection in the Museum, explained the principles of stratification, the parallelism of the beds, and the accidents in nature by which their horizontality is frequently disturbed.] When the beds (continued Mr. Smyth) are raised on one side the inclination is called the "dip," and many important considerations in mining depend on its extent and direction. The district of the Forest of Dean dips from the outside towards the interior, and thus forms a sort of basin. The same kind of formation is observable in other carboniferous districts, and hence the term "coal basin," which so frequently occurs. It also happens that the regularity of the strata near the surface is modified by the action of the atmosphere, by rain and running water, and thus valleys are formed. Inequalities of this kind are productive of great embarrassment to unscientific observers. If, for instance, such an interruption occurred in a bed of coal it would be useless to look for the continuation of that bed in the bottom of the valley, but by going to a sufficient distance, and searching the opposite hill side, it would, probably, be discovered at about the same level. When, however, the horizontality of the beds is much interfered with the problem is one of a more difficult character. The strata (so called from the Latin "stratum"—a bed) are also called "seams" and "cills" in the North of England, and when a certain number occur near to each other they are called "measures," as, for instance, "coal measures" or "stone measures." They are also termed "delfs," and "posts." In Lancashire the word "mine" is, unfortunately, made use of, and is applied to the beds of ironstone in South Wales. In some districts where circular excavations are made the miners call them "girdles." The great point, however, with regard to the stratified deposits is that they consist of layers, the upper portion of which is parallel with the lower. Beds of this kind, having a certain amount of horizontality, are called "conformable" strata, but it sometimes happens that another group of beds will be tilted, so as to lie almost at right angles, or, at any rate, at a considerable angle, to the other beds, and then they are called "unconformable." Wherever the parallelism I have mentioned is found you may be sure you are dealing with a true-bedded deposit, and it will be of great assistance in tracing out particular beds throughout the country. Thus, if you find a bed of black shale overlaid by some yellow substance—say, sandstone—associated with coal, you may be sure, if in another part of the same district you find the shale and the sandstone, that the coal is there also; and this, because it is a known geological fact that beds remain parallel to each other over a large area of country. The dip of a seam is reckoned greater or less according to its angle of inclination from a horizontal line drawn at the surface. Thus, if a line representing the direction of the seam, C, be made to join a horizontal line representing the surface, A B, the distance between the two lines at a yard from the point where they join, B, will give the measure of the dip. Supposing that distance to be 2 ft., the dip will be said to be 2 ft. to the yard. The direction of the dip is usually taken with regard to the meridian, and it is said to be so many degrees to the north or to the south, or to any other point, as the case may be. The "rise" of the dip is its direction towards the surface, and it is then said to be "on the land." In the other direction downwards it is said to be "on the deep." The amount of dip is extremely various, ranging from a few inches off horizontality to very high angles of inclination. In Pembrokeshire there are some beds which are nearly vertical, and in Belgium and the North of France there are seams of coal with their associated beds lying flat in one place, then raised to a high angle, then flat again, so as to represent a zigzag line. This in some places happens to such an extent that a perpendicular shaft passes through the same beds four or five times. You will find as we proceed that the angle of inclination has a great deal to do with the mode of working, and very different methods have to be adopted with flat seams and those highly inclined and almost vertical, which the miners say "stand upon their heads." The straight line, which is taken at right angles to the deep, is called the "course," or "direction," or "strike" of a seam. When you come to the question of thickness of seams great care is requisite, as it very frequently happens that the most deceptive statements on this point are put forward. Care must be taken not to measure the thickness either horizontally or vertically, as in either case the thickness will appear to be very much greater than it really is. The only true measurement is that of a perpendicular line between the two walls or sides. The upper portion of a deposit is called the "roof," and the under portion the "floor" or "sole." Thickness is a point of great importance, but one upon which it is impossible to lay down any rule. I have seen beds of coal as little as 13 in. worked with profit, but such instances are rare. If seams are no more than 2 ft. or 3 ft. they do not receive much attention. Our most famous beds are from 20 ft. to 30 ft. thick, and the "Ten-yard coal" of Staffordshire (so called because its average thickness is 10 yards) is at places as much as 40 ft. In France there are beds which reach even 80 ft. in thickness. The value, however, of a seam of coal does not depend on thickness alone. For instance, a seam 4 ft. or 5 ft. thick may in itself be of very good quality, but if the roof and floor are bad it will be so injured in its commercial aspect that it will not be possible to work it with profit. There is another consideration affecting stratified deposits, which must not be overlooked. If we take a large area we shall find that the beds are very apt to change their character. The parallelism may remain the same, but their condition may be very different. For instance, a very good coal may be found at one place, and a mile or two off in the very same bed it may be mixed with iron pyrites or stone, or other deleterious material. In the same way beds of workable building stone will not necessarily be found as good a mile off, or even half a mile off, and in some cases in the very same quarry a stone will be found at the one end to have different physical conditions from the other. Hence the frequent disappointments which occur, and of which the Houses of Parliament are a notable example. In that building some of the stones offer an admirable resistance to atmospheric influences, while others, although from the same bed, decompose with great facility. The same thing occurs in following out ironstone and other bedded deposits, and I have seen cases in which brown ironstone has changed to blackband, and from that to anthracite coal.



Beds of valuable minerals occasionally enclose within them beds of material which are worthless, generally called "bands," and which are commonly interstratified. When this happens it becomes a question whether it is worth while to continue the work. These bands are sometimes so hard that the workmen's wages for removing them amount to so much as to leave no profit on the good material. Mr. Jukes, in his book on the Coal Field of South Staffordshire, gives an interesting account of some bands which occurred in the Dudley Mines. At the great undersea colliery at Whitehaven a very remarkable case of this kind occurred. The "partings," as they are there called, came in planes parallel with the top and bottom of the seam, and at last were found to interfere so much that the work could not be carried on with advantage, and was abandoned.

When a bed, or seam, comes up to the surface, or "land," the upper part is called the "out-crop," or "basset." This is generally in a very different physical and chemical condition to the bed lower down. In many cases it would hardly be observable, for it mostly happens that coal near the surface is squeezed together into what the miners call "a state of mush." This is also the case with ironstone and other ores of a bedded or stratified character. The most of our highly productive deposits have been discovered by other means. For instance, the great iron district of Cleveland, which only came into notice since 1848, owes its existence to some very heavy masses of stone being found on the seaside at the mouth of the Tees. These were said by some to contain iron, and I recollect being myself in the district about that time, and hearing it suggested that they might make good building stones, but for the production of iron they would be useless. Somebody, however, had the good fortune to discover the beds from whence those stones came, and which since then have turned out millions of tons of iron. There are now upwards of 90 furnaces, some of them on the largest scale in the world, and tens of thousands of people are supported by the works in that single district. It had long been known that the deposits there contained iron ore, but no one dreamt that there was sufficient to form a staple manufacture. The beds are stratified, and are from 16 ft. to 60 ft. in thickness. They have proved a source of enormous wealth, and I am aware of one proprietor alone who has received as much as 35,000*l.* a year, without risk or trouble, from his royalty. Generally speaking, stratified deposits have very different aspects from those which occur in the veins, or lodes, in the metalliferous districts, to which I shall refer in my next lecture. (Cheers.)

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